植物研究雑誌
J. Jpn. Bot.
73: 314–318 (1998)

Chromosome Numbers of *Thelypteris angustifrons* (Miq.) Ching and Two Related Species from Japan

Narumi NAKATO

Kokubunji High School, Shin-machi 3-2-5, Kokubunji, Tokyo, 185-0004 JAPAN

(Received on May 27, 1998)

Chromosome numbers of *Thelypteris angustifrons*, *T. cystopteroides* and *T. glanduligera* were determined in Japanese plants. *T. angustifrons* was hexaploid with 2n=162 (x=27) in eight plants from seven localities. A hyperhexaploid plant with 2n=164 was also detected. *T. cystopteroides* is known to consist of diploid and tetraploid cytotypes based on x=27. In this study, the diploid with 2n=54 was confirmed in one plant. *T. glanduligera* was tetraploid with 2n=108 (x=27) in 14 plants from 13 localities, though different chromosome numbers had been reported outside Japan. As a result, *T. angustifrons* (6x) is confirmed to be distinct from the other two species at the level of ploidy.

In Japan, the genus *Thelypteris* sensu Iwatsuki (1964) comprises some 45 species and varieties (Iwatsuki 1995), and cytological information is now available for 31 taxa (Takamiya 1996). The genus has been of much interest displaying a range of basic chromosome numbers such as x=27, 30, 31, 32, 34, 35 and 36 (Takamiya 1996).

Thelypteris angustifrons (Miq.) Ching, *T. cystopteroides* (D.C.Eaton) Ching and *T. glanduligera* (Kunze) Ching are closely related to one another in external morphology and boundaries between these are often obscure (Iwatsuki 1965). Chromosomal studies are needed for understanding the nature of these species. Previous studies indicated that *T. cystopteroides* is a diploid-tetraploid complex based on x=27 (Mitui 1975, Kurita 1976, Kurizono 1987, Weng and Qiu 1988) with a single exception of the count of n=31 (x=31) from Taiwan (Tsai and Shieh 1985). However chromosomal studies are still insufficient, especially as regards Japanese plants of the other two species; for *T. angustifrons* only one count (n=31) from Taiwan was reported (Tsai and Shieh 1977), whilst for *T. glanduligera* various chromosome numbers with different basic numbers (x=27, 34, 36 and 40) were recorded, mainly outside Japan (Mitui 1968, Tsai and Shieh 1983, 1985, Weng 1985, Weng and Qiu 1988, Matsumoto and Nakaike 1990, Nakato et al. 1995). In the course of my chromosomal studies of Japanese ferns, somatic chromosome counts have been made for these species. The results are reported in this paper.

Materials and Methods

The localities of the materials used in this study are shown in Table 1. The chromosome numbers were counted in root tip cells using the conventional squashing method (cf. Nakato 1987). The voucher specimens were deposited in TI (the Botanical Gardens, Faculty of Science, University of Tokyo).

Results and Discussion

1. *Thelypteris angustifrons* (Miq.) Ching

This species is distributed in China, Tai-

Table 1. List of somatic chromosome numbers, localities and voucher specimens

Species
Chromosome number / Basic number / Ploidy level
Locality / Voucher specimen (Nakato's no.)

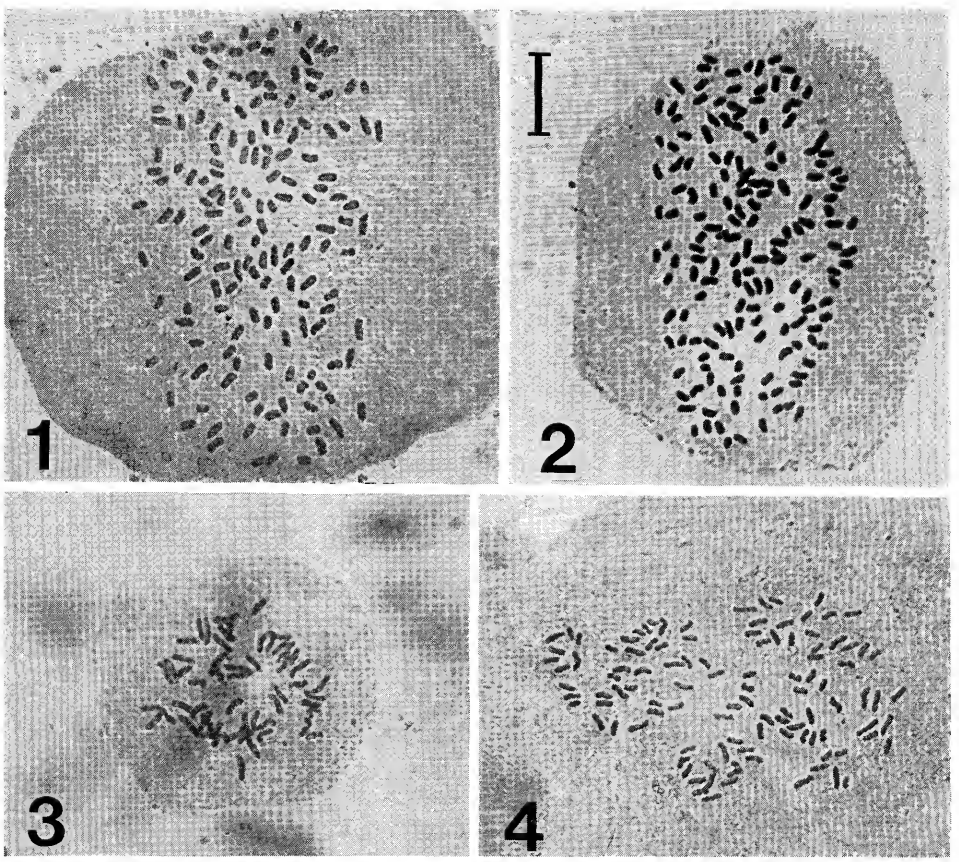
Thelypteris angustifrons (Miq.) Ching
2n=162, x=27, hexaploid
Takada, Shingu-shi, Wakayama Pref., no. 2102*
Kouzuke, Nachikatsuura-cho, Wakayama Pref., nos. 2106, 2116
Shiiba, Sawara-ku, Fukuoka-shi, Fukuoka Pref., no. 2126*
Mochidagaura, Hakata-ku, Fukuoka-shi, Fukuoka Pref., no. 2114*
Hirao-reien, Minami-ku, Fukuoka-shi, Fukuoka Pref., no. 2128
Yoshida-cho, Kagoshima-gun, Kagoshima Pref., no. 2140*
Yoshino-cho, Kagoshima-shi, Kagoshima Pref., no. 2118
2n=164, x=27, hyperhexaploid
Hirao-reien, Minami-ku, Fukuoka-shi, Fukuoka Pref., no. 2129*
T. cystopteroides (D.C. Eaton) Ching
2n=54, x=27, diploid
Naze, Amami-oshima Isl., Kagoshima Pref., no. 1612
T. glanduligera (Kunze) Ching
2n=108, x=27, tetraploid
Tsukubasan, Tsukuba-shi, Ibaraki Pref., no. 1999
Narahashi, Higashiyamato-shi, Tokyo Pref., nos. 1980, 1981
Mizuho-machi, Nishitama-gun, Tokyo Pref., no. 2095
Hakone-machi, Ashigarashimo-gun, Kanagawa Pref., no. 2067
Amagiyugashima-cho, Tagata-gun, Shizuoka Pref., no. 2053
Tatsuruhama-machi, Kashima-gun, Ishikawa Pref., no. 1931
Shiga-machi, Hakui-gun, Ishikawa Pref., no. 1949
Yadokoro, Owase-shi, Mie Pref., no. 2124
Takada, Shingu-shi, Wakayama Pref., no. 2103*
Kouzuke, Nachikatuura-cho, Wakayama Pref., no. 2107
Kamibayashi, Soja-shi, Okayama Pref., no. 2230
Mochidagaura, Hakata-ku, Fukuoka-shi, Fukuoka Pref., no. 2111
Yoshino-cho, Kagoshima-shi, Kagoshima Pref., no. 2119*

* Specimens examined for the number of spores per sporangium. All these have 64 good spores in each sporangium.

wan, Korea and Japan. Tsai and Shieh (1977) reported that a plant from Taiwan showed n=31 (diploid of x=31) and sexual in reproductive mode. However, eight plants from seven localities in Japan examined in this study were found to have 2n=162 chromosomes (Fig. 1). Sporogenesis was examined in four plants, in each of which the sporangia produced 64 good spores. Therefore, the Japanese plants of this species are sexual hexaploids based on x=27. An aneuploid plant with 2n=164 (hyperhexaploid) was also discovered in one of the above localities (Fig. 2). The spore production of this plant was normal, producing 64 good spores per sporangium.

Tsai and Shieh (1977) reported from Taiwan the diploid cytotype with x=31, by whom only one individual plant was examined. Therefore, re-examination is required on Taiwanese populations.

2. *Thelypteris cystopteroides* (D.C.Eaton) Ching



Figs. 1–4. Micrographs of somatic chromosomes. 1. *Thelypteris angustifrons*. 2n=162, no. 2102. 2. *T. angustifrons*, 2n=164, no. 2129. 3. *T. cystopteroides*, 2n=54, no. 1612. 4. *T. glanduligera*, 2n=108, no. 2103. Scale bar = 10 μm.

This species is distributed in S. China, Taiwan and S. Japan. Previous cytological studies revealed that this species have two cytotypes based on x=27. Diploid sexual cytotype was recorded by Mitui (1975; from cultivated plants) and Kurizono (1987; from Isl. Amami-oshima, Kagoshima Pref.), and tetraploid sexual by Kurita (1976; from Isl. Yakushima, Kagoshima Pref.), Kurizono (1987; from Miyajima, Hiroshima Pref.) and Weng and Qiu (1988; from China). In contrast, Tsai and Shieh (1985) reported a diploid with n=36 (x=36) in one Taiwanese specimen.

In the present study, an individual plant collected at Isl. Amami-oshima, Kagoshima Pref., was found to have 2n=54 chromosomes, being diploid based on x=27 (Fig. 3). The reproductive mode of this plant could not be ascertained because of lack of suitable fertile fronds for spore examination. From these data, the tetraploid seems to have wider distribution range than the diploid which is known only from Isl. Amami-oshima.

3. *Thelypteris glanduligera* (Kunze) Ching

This species is widely distributed in S.E. Asia, including N. India, Indonesia, Thailand, China, Taiwan, Korea and Japan. This is cytologically problematical, because various chromosome numbers based on different basic numbers such as x=27, 34, 36 and 40 were

reported, mainly from outside Japan. The tetraploid of x=27 was recorded by Weng (1985; from China), and Matsumoto and Nakaike (1990; from Nepal), the diploid of x=34 by Tsai and Shieh (1983; from Taiwan), the tetraploid of x=34 by Weng and Qiu (1988; from China), the diploid of x=36 by Mitui (1968; from Kuki, Mie Pref.), and Tsai and Shieh (1985; from Taiwan), and the diploid of x=40 by Nakato et al. (1995; from China).

In this study, all 14 plants examined from 13 localities were proved to have 2n=108 chromosomes, indicating that they were tetraploid based on x=27 (Fig. 4). The present results agree with those reported by Weng (1985), and Matsumoto and Nakaike (1990), from China and Nepal, respectively. The production of 64 spores per sporangium was observed in two samples. Thus, the Japanese plants of this species are probably sexual in reproduction.

Plants based on x=34, 36 or 40 have not been detected in the present materials. Further studies, especially from outside Japan, are required for better understanding the cytological nature in this species.

In conclusion the present study proves that the chromosome numbers of *T. angustifrons*, *T. cystopteroides* and *T. glanduligera* in Japan are based on the same basic number, x=27, and the first species is distinct from the other two at the level of ploidy reached, namely hexaploid. The morphological resemblance (Iwatsuki 1965) and the common basic number in the three species strongly suggest that they might be regarded as a diploid-tetraploid-hexaploid species complex, sharing partly the same genomic constitution(s). This hypothesis must be checked by further investigations.

The author thanks Dr. Trevor G. Walker of Newcastle upon Tyne, United Kingdom, for valuable comments. The author also thanks Messrs. K. Ohora (Wakayama), S. Tutui (Fukuoka) and M. Kawabata (Kagoshima), for supplying some materials.

References

Iwatsuki K. 1964, 1965. Taxonomy of the thelypteroid ferns, with special reference to the species of Japan and adjacent regions III, IV. Mem. Coll. Sci. Kyoto Univ. ser. B **31**: 11–40, 125–197.

——— 1995. Thelypteridaceae. *In*: Iwatsuki K., Yamazaki T., Bufford D.E. and Ohba H. (eds.), Flora of Japan **1**: 174–194. Kodansha, Tokyo.

Kurita S. 1976. Chromosome numbers of some Japanese ferns 9. La Kromosomo **II-2**: 69–76.

Kurizono S. 1987. Cytological studies on some taxa in thelypteroid ferns, Aspidiaceae. La Kromosomo **II-46**: 1513–1520.

Matsumoto S. and Nakaike T. 1990. Cytological observations of some ferns in Nepal (1). On the related taxa in Japan. *In*: Watanabe M. and Malla S.B. (eds.), Cryptogams of the Himalayas **2**: 163–178. National Science Museum, Tsukuba.

Mitui K. 1968. Chromosomes and speciation in ferns. Sci. Rep. Tokyo Kyoiku Daigaku, Sec. B., **13**: 285–333.

——— 1975. Chromosome numbers of Japanese pteridophytes. Bull. Nippon Dental Coll., General Educ. **4**: 221–271.

Nakato N. 1987. Notes on chromosomes of Japanese pteridophytes (1). J. Jpn. Bot. **62**: 261–267.

———, Kato M. and Liu B.-D. 1995. A cytotaxonomic study of some ferns from Jiangsu and Zhejiang Provinces, China. J. Jpn. Bot. **70**: 194–204.

Takamiya M. (ed.). 1996. Index to chromosome numbers of Japanese Pteridophyta (1910–1996). Japan Pterid. Soc., Tokyo.

Tsai J.-L. and Shieh W.-C. 1977. Chromosome numbers of the fern family Aspidiaceae (sensu Copeland) in Taiwan (2). J. Sci. Engin. **14**: 91–104.

——— and ——— 1983. A cytotaxonomic survey of pteridophytes in Taiwan. J. Sci. Engin. **20**: 137–158.

——— and ——— 1985. A cytotaxonomic survey of the fern family Aspidiaceae (sensu Copeland) in Taiwan. J. Sci. Engin. **22**: 121–144.

Weng R.-F. 1985. Observation on chromosomes of some Chinese ferns. J. Wuhan Bot. Res. **3**: 367–370.

——— and Qiu S.-P. 1988. Chromosome counts of some ferns from Zhejiang. Invest. Stud. Nat. **8**: 43–52.

中藤成実：コハシゴシダとその近縁種2種の染色体数

日本産のコハシゴシダとその近縁種であるヒメハシゴシダ，ハシゴシダの染色体数を算定した．コハシゴシダでは7産地9個体を調査したが，8個体は2n＝162であり，染色体基本数27の6倍体であった．1産地では正6倍体とともに2n＝164の高6倍体も見つかった．ヒメハシゴシダには基本数27の2倍体と4倍体が知られているが，今回の研究で調べることのできた1個体は2倍体であった．ハシゴシダでは13産地からの14個体で2n＝108（x＝27の4倍体）が観察された．本種の基本数は34，36，40であるとの報告があるが，このことについてはさらに調査を要する．以上の結果から，6倍性を示すコハシゴシダは倍数性に関して他の2種とは明確に区別されることが確認された．外部形態の類似および27という共通の染色体基本数から，日本産のこれら3種は少なくとも一部に共通のゲノムをもつのではないかと推察された．

（東京都立国分寺高等学校）